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# PROJECT TECHNICAL REPORT

# USER'S MANUAL FOR THE GNAT COMPUTER PROGRAM
# (NUMERICAL ANALYSIS OF STRATIFICATION IN SUPERCRITICAL OXYGEN)
# MSC/TRW TASK 705-2

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## ABSTRACT

This report is the User's Manual for the General Numerical Analysis of Transport (GNAT) computer program which is a detailed stratification model of the Apollo supercritical oxygen storage tank. The program was developed under MSC/TRW Task 705-2, "Apollo Cryogenic Storage System (CSS) Analysis," Subtask 2. Numerical methods are used in the program to solve the conservation equations which govern the behavior of a compressible fluid under low accelerations. The program computes the pressure, temperature, density, and velocity components at points distributed throughout the fluid in the tank. Real fluid properties permit the calculation of potential pressure collapse due to the sudden mixing of a thermally stratified fluid. Although the program normally requires a significant amount of computer time to execute, scaling of pertinent parameters may be used to reduce this required time. In addition, program re-start capability is also provided by storage of output data on magnetic tape.

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TABLES

# 1.0 INTRODUCTION

The operating procedures of the General Numerical Analysis of Transport (GNAT) computer program are described in this report. The GNAT program was developed under Subtask 2 of MSC/TRW 705-2, "Apollo Cryogenic Storage System (CSS) Analysis," as specified in the Task Plan (Reference 1).

The GNAT program was developed as a detailed stratification analysis model of the Apollo supercritical oxygen storage tanks. The purpose of this program is to provide means of predicting pressure collapses associated with supercritical fluid destratification caused by sudden vehicle accelerations.

The program employs a numerical solution of the conservation equations governing a compressible fluid. Details of this method may be found in Reference 2. The Programmer's Guide (Reference 3) contains a compilation and detailed flowcharts of the GNAT Program including descriptions of all subroutines used in the program.

## 2.0 PROGRAM DESCRIPTION

### 2.1 Program Definition

The GNAT computer program is used to model in detail the effects of localized heating, fluid withdrawal, and low acceleration environments on thermal stratification and mixing of compressible fluids. Pressure collapse occurring in supercritical oxygen in thermal non-equilibrium is computed using real-fluid properties.

### 2.2 Method of Solution

A two-dimensional volume is characterized in rectangular coordinates by a number of cubic nodes. The governing conservation equations in Eulerian coordinates are expressed in finite-difference form such that the basic fluid variables are explicit with respect to the time variable. The state of the fluid is assumed known at each node center at some time, $t^\circ$, either as initially input or as the result of the previous calculation. The mass, momentum, and energy are obtained at some incremental time later, $t' = t^\circ + \Delta t$ by applying the conservation equations at each node center. At each node, the temperature is computed from the energy, and the pressure is computed from the temperature and density. Both of these parameters are obtained from real-fluid property data.

This procedure is repeated successively, advancing time at $\Delta t$ each step, until the desired end time is reached.

## 3.0 INPUT DATA

Data may be entered into the program through punched card input or through a previously generated magnetic tape.

### 3.1 Card Input

The primary means of entering data to the program is by card input. These data include the node geometry, initial fluid steady-state conditions, boundary conditions, program control data, and certain physical property data.

All card data is entered according to standard NAMELIST convention which is described briefly here. NAMELIST is a free-field card input routine. This program contains one NAMELIST statement which was given the name INPUT. The five array names CTL, ITAPE, PRØP, NG, and NS appear in this NAMELIST. Upon executing the READ statement, the routine begins reading cards one at a time, expecting a card containing $INPUT in columns 2-7. Cards read before reaching the $INPUT card are ignored by the NAMELIST routine and therefore may be used as descriptive cards to identify the problem to be solved (see section 4.1 PRINTED ØUTPUT). When using this input routine, card column 1 must be blank.

Input data appear on cards following the $INPUT card. The name of the variable is punched on the card, followed by an equal sign, followed by the numerical value assigned to that specific variable. The variables used in this program are arrays so that a list of values, separated by commas, may follow the equal sign and will be inserted into successive locations within the array. A subscript may be given with the array name in which case the list of data will be inserted into the array beginning at the specified element. The list may consist of only a single value.

The reading of data cards by the NAMELIST input routine is terminated by a card containing $END in columns 2-5.

The internal programing variables are equivalenced to various locations within the five arrays input by the NAMELIST routine. The first three arrays contain physical property data, initial conditions, and program control data. The last two contain the beginning and ending indicies for the desired node geometry. Default values will produce a circular geometry of 20-node diameter. Array ITAPE contains the information for the optional tape read/write capability. The definition and units of individual input variables in these arrays are presented in Tables 1 through 4.

### 3.2 Magnetic Tape Input

The program has been given an optional restart capability. A magnetic tape data record generated by a previously run case may be input. This data record contains all property data, program control data, and fluid state data necessary to continue the previously run case by a second program execution. The program bypasses the initializing instructions and takes the fluid state input from magnetic tape as the starting conditions for the second run. In particular, the established fluid velocities are used as initial conditions for the second run.

After the tape data have been read into the program, the user is permitted to adjust certain property and program control data to apply during the new run. The NAMELIST cards $INPUT and $END must appear since card input is expected after tape input even if no data is adjusted. For example, the program stop time normally would be extended. In addition, heating rates, fluid withdrawal rate, and g-level may be adjusted to reflect changing conditions. The computation time step ($\Delta t$), fluid viscosity (VSC), and thermal conductivity (K) can be adjusted at this time.

TABLE 1

INPUT ARRAY CTL

| I | CTL | DESCRIPTION | UNITS |
|---|---|---|---|
| 1 | TSTART | Program start line, $t_o$ | sec |
| 2 | DT | Integration time step, $\Delta t$ | sec |
| 3 | TSTØP | Program stop time, $t_f$ | sec |
| 4 | DTPR | Data output time interval, $\Delta t_{print}$ | sec |
| 5 | WDØT | Tank mass flowrate, $\dot{w}$ | lbm/hr |
| 6 | DQHERT | Tank heater input, $\dot{q}$ heater | B/hr |
| 7 | DQBC(1) | Boundary heat flux-left wall | $B/ft^2$-hr |
| 8 | DQBC(2) | Boundary heat flux-right wall | $B/ft^2$-hr |
| 9 | DQBC(3) | Boundary heat flux-bottom wall | $B/ft^2$-hr |
| 10 | DQBC(4) | Boundary heat flux-top wall | $B/ft^2$-hr |
| 11 | GX | Acceleration, x-component, $g_x$ | g's |
| 12 | GY | Acceleration, y-component, $g_y$ | g's |
| 13 | SCALE | Scale factor | - |
| 14 | ITAPE(1) | Tape I/O control described in Table 2. | |
| 15 | ITAPE(2) | | |
| 16 | ITAPE(3) | | |
| 17 | ITAPE(4) | | |
| 18 | ITAPE(5) | | |
| 19 | ITAPE(6) | | |
| 20 | STOPFG | Program stop flag. Stop if $\geq 1$. | |

TABLE 2

INPUT ARRAY ITAPE

| I | ITAPE(I) | DESCRIPTION |
|---|---|---|
| 1 | IUNITR | Tape unit for input state data |
| 2 | IFILER | File of input data on IUNITR |
| 3 | IRECR | Record of input data in IFILER |
| 4 | IUNITW | Tape unit to output state data |
| 5 | IFILEW | File of output data on IUNITW |
| 6 | IRECW | Record of output data in IFILEW |

Note: Since ITAPE is equivalenced to CTL, the tape control data may be input under either variable name.

TABLE 3

INPUT ARRAY PROP

| I | PRØP(I) | DESCRIPTION | UNITS |
|---|---|---|---|
| 1 | - | | |
| 2 | - | | |
| 3 | K | Thermal Conductivity | B/ft-hr-°R |
| 4 | VSC | Absolute Viscosity | Poise |
| 5 | - | | |
| 6 | L | Node dimension | ft |
| 7 | - | | |
| 8 | PO | Initial pressure | psi |
| 9 | TO | Initial temperature | °R |
| 10 | PFLAG | Heater flag: 1 = on, 0 = off | - |

TABLE 4

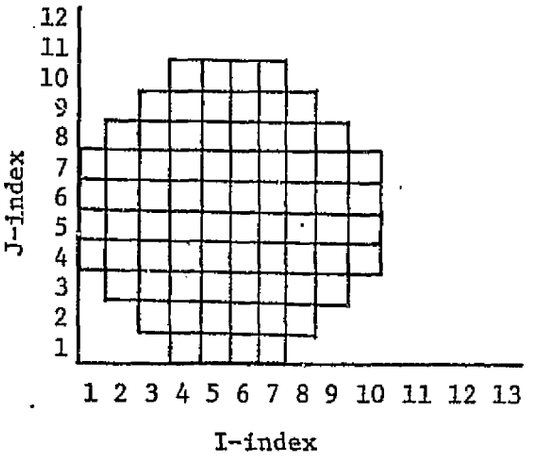
INPUT ARRAYS NG AND NS

Storage has been allocated for 400 nodes arranged in a 20 x 20 node square. However, configurations other than a square may be defined by giving the starting and ending values of the J-index at each value of I and of the I-index at each value of J such that

$$NG(I) \leq J \leq NS(I) \qquad I = 1,20$$

$$NG(J) \leq I \leq NS(J) \qquad J = 1,20$$

The result of defining the x- and y- limits by the same arrays is that the geometry is symmetric with respect to the 45° line between the x- and y- axes. An example of a 10- node diameter configuration is defined below.




| J | NG(J) | NS(J) |
|---|---|---|
| 12 | 0 | x |
| 11 | 0 | x |
| 10 | 4 | 7 |
| 9 | 3 | 8 |
| 8 | 2 | 9 |
| 7 | 1 | 10 |
| 6 | 1 | 10 |
| 5 | 1 | 10 |
| 4 | 1 | 10 |
| 3 | 2 | 9 |
| 2 | 3 | 8 |
| 1 | 4 | 7 |

Note that the first zero appearing in the NG-array (11th value in this example) causes the series to be terminated.

Since the initializing instructions are skipped when tape input is used, adjustment of initial condition data such as pressure and temperature is not meaningful. The scale factor (SCALE) should be adjusted with care since the artificial pressure gradient (Reference 2) is affected by this change.

The following information punched on data cards is typical and will cause the third record of file 2 to be read from the tape on Unit 1 (logical unit A). Tape units 1 through 4 and 7 through 9 may be used.

```
CARD COLUMN 2
$INPUT
ITAPE (1) = 1, 2, 3
$END
```

## 4.0 OUTPUT DATA

Output data is provided automatically by the program at intervals specified by the input variable DTPR. This data also is provided after a program abort. Two types of output are used: printed output and the optional magnetic tape output.

### 4.1 Printed Output

Printed output is generated at four points in the program:

(1) All card input data is read in and immediately printed out as read by the subroutine CR2TAP which operates in conjunction with the NAMELIST input routine. Preceding the $INPUT card and input data, descriptive information may be supplied which will appear on the printed output. Operation of the CR2TAP subroutine is terminated by the NAMELIST termination card $END.

(2) If a magnetic tape is being read or written, subroutine TAPEIØ will print out the numbers of tape unit, file, and record during the execution of a tape positioning instruction. An example of the printed output is: NTRAN UNIT 1 IS ON FILE 1 RECORD 2.

(3) The standard printed output consists of a summary of selected fluid property data followed by five tables containing detailed node state data. Description and units of the output variables are shown ir Table 5. Sample print out is shown in Section 5.4.

(4) The automatic cycling of the heater according to the bulk pressure is shown by an independently printed line of output such as:

.500000 + 01 PFLAG = 1

which indicates that the heater was turned on at the program time 5.0 seconds. PFLAG = 0 would indicate that the heater was turned off at the time shown.

## 4.2 Magnetic Tape Output

To provide a re-start capability, the program has an option to generate data records on magnetic tape. This option is exercised by specifying the number of an appropriate tape unit on which the output tape is to be mounted along with starting file and record numbers (IUNITW, IFILEW, IRECW). A record consists of the 3700 words stored in the master I/O array, A. A record will be written at print intervals specified by DTPR. The data contained in one of these records is sufficiently thorough to enable the case to be continued without additional data input.

After a normal execution in which the program terminated upon reaching the stop time, TSTOP, an end of file mark will be written on the tape. In case of a program abort, the EOF mark will not appear.

The following information on input data cards is typical and would cause an output tape to be generated on unit 2 (logical unit B) beginning with file 3, record 1. Tape units 1 through 4 and 7 through 9 may be used.

```
CARD COLUMN 2
$INPUT
.
.
.
ITAPE (4) = 2, 3, 1
.
.
.
$END
```

TABLE 5

STANDARD OUTPUT DATA

Following a program title, a row of ten numbers is printed. These are as follows:

| | |
|---|---|
| 1 | program time, t (seconds) |
| 2 | program time increment, $\Delta t$ (seconds) |
| 3 | scaled problem time, $t_s$ (minutes) |
| 4 | average node pressure, $\bar{p}$ (psi) |
| 5 | average node density, $\bar{\rho}$ (lbm/ft$^3$) |
| 6 | lowest node temperature, $T_{min}$ (°R) |
| 7 | average node temperature, $\bar{T}$ (°R) |
| 8 | highest node temperature, $T_{max}$ (°R) |
| 9 | equilibrium (collapse) pressure, $P_{col}$ (psi) |
| 10 | total fluid mass, wt (lbm) |

The five detailed tabulations which show values at each individual node contain the following information.

| | |
|---|---|
| Tabulation 1 | Relative pressure, $P-\bar{P}$ (psi) |
| Tabulation 2 | Relative density, $\rho-\bar{\rho}$ (lbm/ft$^3$) |
| Tabulation 3 | Relative temperature, $T-\bar{T}$ (°R) |
| Tabulation 4 | X-component velocity, u (ft/sec) |
| Tabulation 5 | Y-component velocity, v (ft/sec) |

The TIME value shown with the tabulations is the scaled problem time (minutes).

## 5.0 Operating Procedures

### 5.1 System Requirements

The program is coded in Fortrum V language and has been executed under the Univac 1108 Exec. II system of the NASA/MSC computing facility. One magnetic drum file is used as the intermediate unit for card data input. One magnetic tape unit is used to input the function OPTD from a CUR tape. Tape units also are used as required for the tape read/write options.

### 5.2 Program Operation

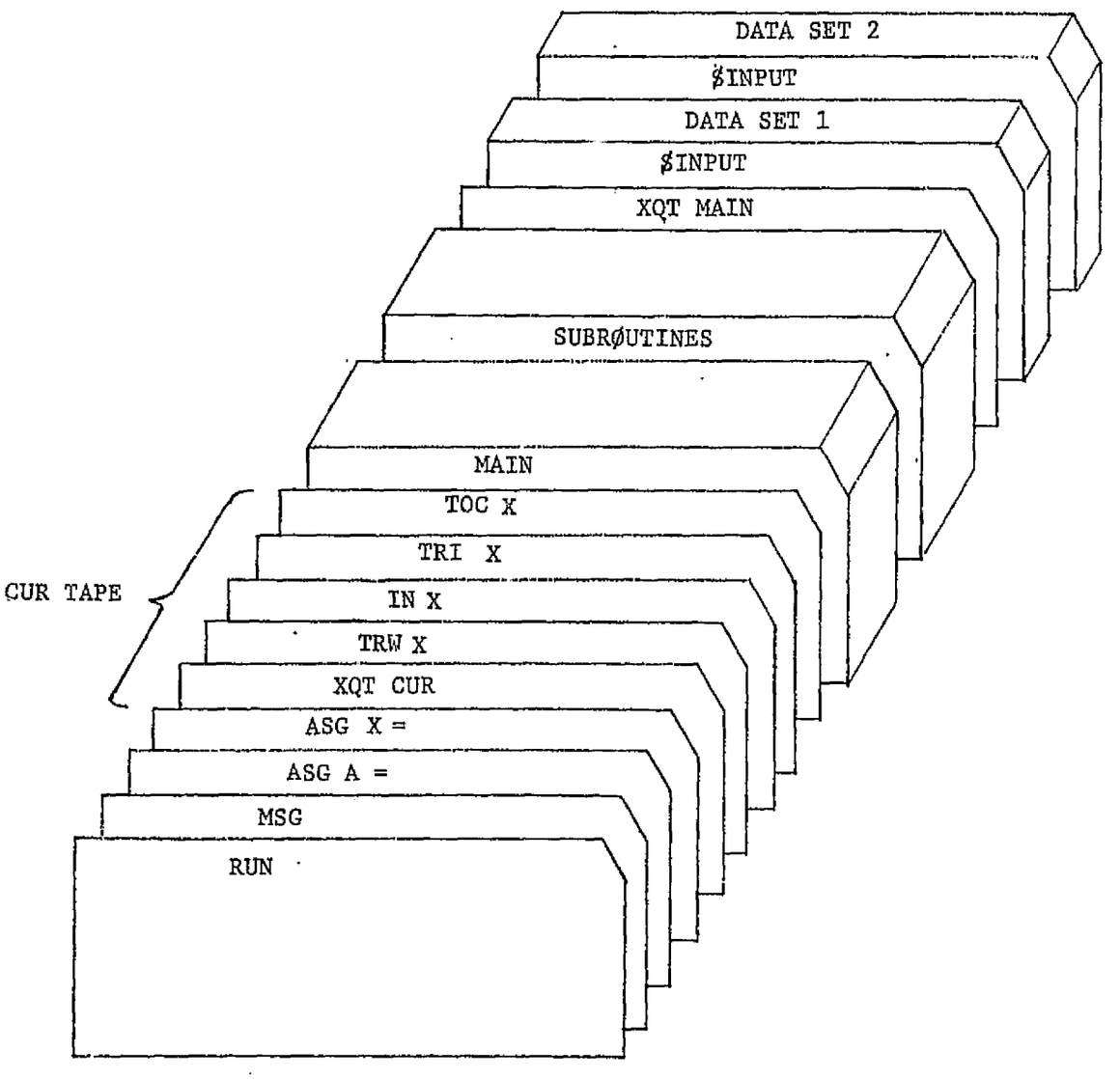
For problems started from initial conditions specified by card input as shown in Figure 6 (not restarted from a previously-computed state stored on tape) the function OPTD must be loaded from a CUR tape. This function is used to establish the initial fluid density distribution.

The program will compute the appropriate initial conditions based upon the input initial pressure and temperature unless an input data tape unit is specified (e.g. ITAPE(1) = 1, 1, 5). If an input data tape is used, a second set of input card data is expected. Input tape data is read in over the previously existing data so that card data cannot be entered at the same time that tape data is input.

Execution of the program will procede until the program time has been incremented to the stop time. An internal test for instability is made. Instability is sensed by a negative node density which initiates the case termination. Upon completion of a case, if the last-case flag (CTL(20)>0) has not been set, the program will attempt to read the next set of input card data.

FIGURE 6

TYPICAL DECK SETUP



## 5.3 Deck Setup

Figure 6 shows a typical deck setup in which the subroutine OPTD is input from a CUR tape. Two sets of card input data are illustrated. However, an indifinite number of data sets may be used. The program stop flag (CTL (20)=2) is used in the last data set for normal program termination.

## 5.4 Sample Output

The following pages show the computer output generated for a typical case. The actual case run was a simulation of an Apollo oxygen tank under low acceleration. A circular cross section employing maximum resolution (20-node diameter) was used. No input data tape was requested so that the initial conditions were computed from the input pressure (850 psi) and temperature (200 °R). The initial node velocities were set to zero throughout the volume. A one-node heater is hard-coded at the location I=12, J-10.

Note that descriptive cards were used before the $INPUT card. An output data tape was specified by ITAPE(4) = 1,1,1. Data card input was terminated by the $END card. After card data input was complete, the output tape was positioned as specified.

The initial conditions generated by the program are shown at TIME = .000. After the first standard printout, the line .500000-04 PFLAG=1. indicates that the heater was turned on after the first time step.

The next output occurred at the program time .0125 seconds which, with a scale factor of 2400, corresponds to a problem time of 0.5 minutes. The tape positioning subroutine indicates that the output tape was positioned at record 2. The detailed tabulations show the values of relative pressure, relative density, relative temperature, x-component, velocity, and y-component velocity at each node for the problem time 0.5 minutes.

```
CARD COL      1        2        3        4        5        6        7        8
 1.* * APOLLO BOTTLE CROSS SECTION - 20 NODE DIAMETER                        *
 2.* * HEATER NODES - I = 12, J = 10                                         *
 3.* * SCALE FACTOR IS 2400                                                  *
 4.* * GY = -2. E-8                                                          *
 5.* *                                                                       *
 6.* *                                                                       *
 7.* $INPUT                                                                  *
 8.* PROP(4) = 1.2E-2                                                        *
 9.* PROP(8)= 850., 200.                                                     *
10.* CTL(12) = -2.E-8                                                        *
11.* CTL(13) = 2400.                                                         *
12.* CTL(5) = 1.4                                                            *
13.* CTL(6) = 528.6                                                          *
14.* CTL(2) = .5E-4, .6, .025                                                *
15.* CTL(3) = .9                                                            *
16.* CTL(4) = .0125                                                         *
17.* ITAPE(4) = 1,1,1                                                       *
18.* CTL(20) = 7.                                                           *
19.* $END                                                                   *
NTRAN UNIT  1 IS ON FILE  1 RECORD  1
```

15

12
11
10

GENERAL NUMERICAL ANALYSIS OF TRANSPORT P J REINHILLER

.0000000 .5000000-04 .0000000 .8500000+03 .6545085+02 .0000000 .0000000 .0000000 .0000000 .0000000

RELATIVE PRESSURE (PSI)

NTRAN UNIT 1 IS ON FILE 1 RECORD 1

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .16358+02 | .16358+02 | .16358+02 |
| 19 | .00000 | .00000 | .00000 | .00000 | .00000 | .16362+02 | .16362+02 | .16362+02 | .16362+02 | .16362+02 |
| 18 | .00000 | .00000 | .00000 | .16367+02 | .16367+02 | .16367+02 | .16367+02 | .16367+02 | .16367+02 | .16367+02 |
| 17 | .00000 | .00000 | .16370+02 | .16370+02 | .16370+02 | .16370+02 | .16370+02 | .16370+02 | .16370+02 | .16370+02 |
| 16 | .00000 | .00000 | .16375+02 | .16375+02 | .16375+02 | .16375+02 | .16375+02 | .16375+02 | .16375+02 | .16375+02 |
| 15 | .00000 | .16379+02 | .16379+02 | .16379+02 | .16379+02 | .16379+02 | .16379+02 | .16379+02 | .16379+02 | .16379+02 |
| 14 | .00000 | .16383+02 | .16383+02 | .16383+02 | .16383+02 | .16383+02 | .16383+02 | .16383+02 | .16383+02 | .16383+02 |
| 13 | .16387+02 | .16387+02 | .16387+02 | .16387+02 | .16387+02 | .16387+02 | .16387+02 | .16387+02 | .16387+02 | .16387+02 |
| 12 | .16390+02 | .16390+02 | .16390+02 | .16390+02 | .16390+02 | .16390+02 | .16390+02 | .16390+02 | .16390+02 | .16390+02 |
| 11 | .16395+02 | .16395+02 | .16395+02 | .16395+02 | .16395+02 | .16395+02 | .16395+02 | .16395+02 | .16395+02 | .16395+02 |
| 10 | .16399+02 | .16399+02 | .16399+02 | .16399+02 | .16399+02 | .16399+02 | .16399+02 | .16399+02 | .16399+02 | .16399+02 |
| 9 | .16404+02 | .16404+02 | .16404+02 | .16404+02 | .16404+02 | .16404+02 | .16404+02 | .16404+02 | .16404+02 | .16404+02 |
| 8 | .16407+02 | .16407+02 | .16407+02 | .16407+02 | .16407+02 | .16407+02 | .16407+02 | .16407+02 | .16407+02 | .16407+02 |
| 7 | .00000 | .16411+02 | .16411+02 | .16411+02 | .16411+02 | .16411+02 | .16411+02 | .16411+02 | .16411+02 | .16411+02 |
| 6 | .00000 | .16416+02 | .16416+02 | .16416+02 | .16416+02 | .16416+02 | .16416+02 | .16416+02 | .16416+02 | .16416+02 |
| 5 | .00000 | .00000 | .16420+02 | .16420+02 | .16420+02 | .16420+02 | .16420+02 | .16420+02 | .16420+02 | .16420+02 |
| 4 | .00000 | .00000 | .16423+02 | .16423+02 | .16423+02 | .16423+02 | .16423+02 | .16423+02 | .16423+02 | .16423+02 |
| 3 | .00000 | .00000 | .00000 | .16428+02 | .16428+02 | .16428+02 | .16428+02 | .16428+02 | .16428+02 | .16428+02 |
| 2 | .00000 | .00000 | .00000 | .00000 | .00000 | .16432+02 | .16432+02 | .16432+02 | .16432+02 | .16432+02 |
| 1 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .16436+02 | .16436+02 | .16436+02 |

TIME = .000

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | .16358+02 | .16358+02 | .16358+02 | | | | | | | |
| 19 | .16362+02 | .16362+02 | .16362+02 | .16362+02 | .16362+02 | | | | | |
| 18 | .16367+02 | .16367+02 | .16367+02 | .16367+02 | .16367+02 | .16367+02 | .16367+02 | | | |
| 17 | .16370+02 | .16370+02 | .16370+02 | .16370+02 | .16370+02 | .16370+02 | .16370+02 | .16370+02 | | |
| 16 | .16375+02 | .16375+02 | .16375+02 | .16375+02 | .16375+02 | .16375+02 | .16375+02 | .16375+02 | | |
| 15 | .16379+02 | .16379+02 | .16379+02 | .16379+02 | .16379+02 | .16379+02 | .16379+02 | .16379+02 | .16379+02 | |
| 14 | .16383+02 | .16383+02 | .16383+02 | .16383+02 | .16383+02 | .16383+02 | .16383+02 | .16383+02 | .16383+02 | |
| 13 | .16387+02 | .16387+02 | .16387+02 | .16387+02 | .16387+02 | .16387+02 | .16387+02 | .16387+02 | .16387+02 | .16387+02 |
| 12 | .16390+02 | .16390+02 | .16390+02 | .16390+02 | .16390+02 | .16390+02 | .16390+02 | .16390+02 | .16390+02 | .16390+02 |
| 11 | .16395+02 | .16395+02 | .16395+02 | .16395+02 | .16395+02 | .16395+02 | .16395+02 | .16395+02 | .16395+02 | .16395+02 |
| 10 | .16399+02 | .16399+02 | .16399+02 | .16399+02 | .16399+02 | .16399+02 | .16399+02 | .16399+02 | .16399+02 | .16399+02 |
| 9 | .16404+02 | .16404+02 | .16404+02 | .16404+02 | .16404+02 | .16404+02 | .16404+02 | .16404+02 | .16404+02 | .16404+02 |
| 8 | .16407+02 | .16407+02 | .16407+02 | .16407+02 | .16407+02 | .16407+02 | .16407+02 | .16407+02 | .16407+02 | .16407+02 |
| 7 | .16411+02 | .16411+02 | .16411+02 | .16411+02 | .16411+02 | .16411+02 | .16411+02 | .16411+02 | .16411+02 | |
| 6 | .16416+02 | .16416+02 | .16416+02 | .16416+02 | .16416+02 | .16416+02 | .16416+02 | .16416+02 | .16416+02 | |
| 5 | .16420+02 | .16420+02 | .16420+02 | .16420+02 | .16420+02 | .16420+02 | .16420+02 | .16420+02 | | |
| 4 | .16423+02 | .16423+02 | .16423+02 | .16423+02 | .16423+02 | .16423+02 | .16423+02 | .16423+02 | | |
| 3 | .16428+02 | .16428+02 | .16428+02 | .16428+02 | .16428+02 | .16428+02 | .16428+02 | | | |
| 2 | .16432+02 | .16432+02 | .16432+02 | .16432+02 | .16432+02 | | | | | |
| 1 | .16436+02 | .16436+02 | .16436+02 | | | | | | | |

RELATIVE DENSITY (LBM/FT$^3$)

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | -.56618-04 | -.56618-04 | -.56618-04 |
| 19 | .00000 | .00000 | .00000 | .00000 | .00000 | -.49901-04 | -.49901-04 | -.49901-04 | -.49901-04 | -.49901-04 |
| 18 | .00000 | .00000 | .00000 | -.44143-04 | -.44143-04 | -.44143-04 | -.44143-04 | -.44143-04 | -.44143-04 | -.44143-04 |
| 17 | .00000 | .00000 | -.38385-04 | -.38385-04 | -.38385-04 | -.38385-04 | -.38385-04 | -.38385-04 | -.38385-04 | -.38385-04 |
| 16 | .00000 | .00000 | -.31668-04 | -.31668-04 | -.31668-04 | -.31668-04 | -.31668-04 | -.31668-04 | -.31668-04 | -.31668-04 |
| 15 | .00000 | -.25910-04 | -.25910-04 | -.25910-04 | -.25910-04 | -.25910-04 | -.25910-04 | -.25910-04 | -.25910-04 | -.25910-04 |
| 14 | .00000 | -.19193-04 | -.19193-04 | -.19193-04 | -.19193-04 | -.19193-04 | -.19193-04 | -.19193-04 | -.19193-04 | -.19193-04 |
| 13 | -.14395-04 | -.14395-04 | -.14395-04 | -.14395-04 | -.14395-04 | -.14395-04 | -.14395-04 | -.14395-04 | -.14395-04 | -.14395-04 |
| 12 | -.95963-05 | -.95963-05 | -.95963-05 | -.95963-05 | -.95963-05 | -.95963-05 | -.95963-05 | -.95963-05 | -.95963-05 | -.95963-05 |
| 11 | -.28789-05 | -.28789-05 | -.28789-05 | -.28789-05 | -.28789-05 | -.28789-05 | -.28789-05 | -.28789-05 | -.28789-05 | -.28789-05 |
| 10 | .28789-05 | .28789-05 | .28789-05 | .28789-05 | .28789-05 | .28789-05 | .28789-05 | .28789-05 | .28789-05 | .28789-05 |
| 9 | .95963-05 | .95963-05 | .95963-05 | .95963-05 | .95963-05 | .95963-05 | .95963-05 | .95963-05 | .95963-05 | .95963-05 |
| 8 | .15354-04 | .15354-04 | .15354-04 | .15354-04 | .15354-04 | .15354-04 | .15354-04 | .15354-04 | .15354-04 | .15354-04 |
| 7 | .00000 | .22072-04 | .22072-04 | .22072-04 | .22072-04 | .22072-04 | .22072-04 | .22072-04 | .22072-04 | .22072-04 |
| 6 | .00000 | .28789-04 | .28789-04 | .28789-04 | .28789-04 | .28789-04 | .28789-04 | .28789-04 | .28789-04 | .28789-04 |
| 5 | .00000 | .00000 | .34547-04 | .34547-04 | .34547-04 | .34547-04 | .34547-04 | .34547-04 | .34547-04 | .34547-04 |
| 4 | .00000 | .00000 | .40305-04 | .40305-04 | .40305-04 | .40305-04 | .40305-04 | .40305-04 | .40305-04 | .40305-04 |
| 3 | .00000 | .00000 | .00000 | .47022-04 | .47022-04 | .47022-04 | .47022-04 | .47022-04 | .47022-04 | .47022-04 |
| 2 | .00000 | .00000 | .00000 | .00000 | .00000 | .52780-04 | .52780-04 | .52780-04 | .52780-04 | .52780-04 |
| 1 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .58538-04 | .58538-04 | .58538-04 |

TIME = .000

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | -.56618-04 | -.56618-04 | -.56618-04 | | | | | | | |
| 19 | -.49901-04 | -.49901-04 | -.49901-04 | -.49901-04 | -.49901-04 | | | | | |
| 18 | -.44143-04 | -.44143-04 | -.44143-04 | -.44143-04 | -.44143-04 | -.44143-04 | -.44143-04 | | | |
| 17 | -.38385-04 | -.38385-04 | -.38385-04 | -.38385-04 | -.38385-04 | -.38385-04 | -.38385-04 | -.38385-04 | | |
| 16 | -.31668-04 | -.31668-04 | -.31668-04 | -.31668-04 | -.31668-04 | -.31668-04 | -.31668-04 | -.31668-04 | | |
| 15 | -.25910-04 | -.25910-04 | -.25910-04 | -.25910-04 | -.25910-04 | -.25910-04 | -.25910-04 | -.25910-04 | -.25910-04 | |
| 14 | -.19193-04 | -.19193-04 | -.19193-04 | -.19193-04 | -.19193-04 | -.19193-04 | -.19193-04 | -.19193-04 | -.19193-04 | |
| 13 | -.14395-04 | -.14395-04 | -.14395-04 | -.14395-04 | -.14395-04 | -.14395-04 | -.14395-04 | -.14395-04 | -.14395-04 | -.14395-04 |
| 12 | -.95963-05 | -.95963-05 | -.95963-05 | -.95963-05 | -.95963-05 | -.95963-05 | -.95963-05 | -.95963-05 | -.95963-05 | -.95963-05 |
| 11 | -.28789-05 | -.28789-05 | -.28789-05 | -.28789-05 | -.28789-05 | -.28789-05 | -.28789-05 | -.28789-05 | -.28789-05 | -.28789-05 |
| 10 | .28789-05 | .28789-05 | .28789-05 | .28789-05 | .28789-05 | .28789-05 | .28789-05 | .28789-05 | .28789-05 | .28789-05 |
| 9 | .95963-05 | .95963-05 | .95963-05 | .95963-05 | .95963-05 | .95963-05 | .95963-05 | .95963-05 | .95963-05 | .95963-05 |
| 8 | .15354-04 | .15354-04 | .15354-04 | .15354-04 | .15354-04 | .15354-04 | .15354-04 | .15354-04 | .15354-04 | .15354-04 |
| 7 | .22072-04 | .22072-04 | .22072-04 | .22072-04 | .22072-04 | .22072-04 | .22072-04 | .22072-04 | .22072-04 | |
| 6 | .28789-04 | .28789-04 | .28789-04 | .28789-04 | .28789-04 | .28789-04 | .28789-04 | .28789-04 | .28789-04 | |
| 5 | .34547-04 | .34547-04 | .34547-04 | .34547-04 | .34547-04 | .34547-04 | .34547-04 | .34547-04 | | |
| 4 | .40305-04 | .40305-04 | .40305-04 | .40305-04 | .40305-04 | .40305-04 | .40305-04 | .40305-04 | | |
| 3 | .47022-04 | .47022-04 | .47022-04 | .47022-04 | .47022-04 | .47022-04 | .47022-04 | | | |
| 2 | .52780-04 | .52780-04 | .52780-04 | .52780-04 | .52780-04 | | | | | |
| 1 | .58538-04 | .58538-04 | .58538-04 | | | | | | | |

RELATIVE TEMPERATURE (R)

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 19 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 18 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 17 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 16 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 15 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 14 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 13 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 12 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 11 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 10 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 9 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 8 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 7 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 6 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 5 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 4 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 3 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 2 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 1 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |

TIME = .000

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | .00000 | .00000 | .00000 | | | | | | | |
| 19 | .00000 | .00000 | .00000 | .00000 | .00000 | | | | | |
| 18 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | | | |
| 17 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | | |
| 16 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | | |
| 15 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | |
| 14 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | |
| 13 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 12 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 11 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 10 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 9 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 8 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 7 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | |
| 6 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | |
| 5 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | | |
| 4 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | | |
| 3 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | | | |
| 2 | .00000 | .00000 | .00000 | .00000 | .00000 | | | | | |
| 1 | .00000 | .00000 | | | | | | | | |

18

12
11
10

VELOCITY U (FT/SEC)

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 19 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 18 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 17 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 16 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 15 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 14 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 13 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 12 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 11 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 10 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 9 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 8 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 7 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 6 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 5 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 4 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 3 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 2 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 1 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |

TIME = .000

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | .00000 | .00000 | .00000 | | | | | | | |
| 19 | .00000 | .00000 | .00000 | .00000 | .00000 | | | | | |
| 18 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | | | |
| 17 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | | |
| 16 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | | |
| 15 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | |
| 14 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | |
| 13 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 12 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 11 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 10 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 9 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 8 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 7 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | |
| 6 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | |
| 5 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | | |
| 4 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | | |
| 3 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | | | |
| 2 | .00000 | .00000 | .00000 | .00000 | .00000 | | | | | |
| 1 | .00000 | .00000 | .00000 | | | | | | | |

VELOCITY V (FT/SEC)

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 19 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 18 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 17 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 16 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 15 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 14 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 13 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 12 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 11 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 10 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 9 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 8 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 7 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 6 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 5 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 4 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 3 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 2 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 1 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |

TIME = .000

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | .00000 | .00000 | .00000 | | | | | | | |
| 19 | .00000 | .00000 | .00000 | .00000 | .00000 | | | | | |
| 18 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | | | |
| 17 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | | |
| 16 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | | |
| 15 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | |
| 14 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | |
| 13 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 12 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 11 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 10 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 9 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 8 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 7 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | |
| 6 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | |
| 5 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | | |
| 4 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | | |
| 3 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | | | |
| 2 | .00000 | .00000 | .00000 | .00000 | .00000 | | | | | |
| 1 | .00000 | .00000 | .00000 | | | | | | | |

.500000-04 PFLAG = 1.

* CHAR UN/FLOW AT 024411

* CHAR UN/FLOW AT 024411

* CHAR UN/FLOW AT 024411

* CHAR UN/FLOW AT 024410

* CHAR UN/FLOW AT 02440A

* CHAR UN/FLOW AT 024410

GENERAL NUMERICAL ANALYSIS OF TRANSPORT P. J. HEINMILLER

.1249999-01 .5000000-04 .4999995+00 .8685481+03 .6544808+02 .1999957+03 .2000298+03 .2094832+03 .8683396+03 .2068159+02

RELATIVE PRESSURE (PSI)

NTRAN UNIT 1 IS ON FILE 1 RECORD 2

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | -.56003+00 | -.43342+00 | -.20170+00 |
| 19 | .00000 | .00000 | .00000 | .00000 | .00000 | -.22330+00 | -.17557+00 | -.20643+00 | -.28685+00 | .27880+00 |
| 18 | .00000 | .00000 | .00000 | -.26784-01 | -.45775+00 | -.11774+00 | .11576+00 | -.92888-01 | -.12214+00 | .14728+00 |
| 17 | .00000 | .00000 | -.31645+00 | .40838-01 | -.41840+00 | -.33394-01 | -.17252+00 | -.16109+00 | -.16183+00 | .21571+00 |
| 16 | .00000 | .00000 | -.43832-01 | .58185-01 | -.37078+00 | -.63781-01 | .39960+00 | .16158+00 | .36959+00 | .61646+00 |
| 15 | .00000 | -.68984-01 | -.43599+00 | .18294+00 | -.11288+00 | -.16341-01 | -.14219+00 | .13266+00 | .11204-01 | .30898+00 |
| 14 | .00000 | .17793+00 | .23426+00 | .19300+00 | .20956+00 | -.17559+00 | .23395+00 | .45903+00 | -.35313-02 | .70611+00 |
| 13 | -.80126-01 | .12836+00 | -.17967+00 | .46013+00 | -.25496-01 | -.14579+00 | -.18712+00 | .42986+00 | -.54935+00 | .15744+00 |
| 12 | -.28811+00 | -.18345+00 | -.24980-01 | .58320-01 | .26917+00 | .19572+00 | -.47130+00 | .88524-01 | .13062-01 | .49990+00 |
| 11 | -.68319-03 | -.24266+00 | -.37989+00 | .89114-01 | .34770+00 | .65853+00 | -.36025+00 | .10818-01 | -.12924+01 | -.12879+00 |
| 10 | .11291+00 | .84469-01 | -.15215-01 | .18027+00 | .10803+00 | .18385+00 | .83269-01 | .36837-01 | .33233+00 | .32027+00 |
| 9 | -.58236-01 | -.53136-01 | -.45216-01 | .23396+00 | -.15004+00 | -.12791+00 | -.55342+00 | .39484-02 | -.83697+00 | .57527+00 |
| 8 | -.31655+00 | -.45385+00 | -.11876+00 | -.76199-01 | .89462-02 | .26917+00 | -.53466+00 | .46949+00 | .37827+00 | .97094+00 |
| 7 | .00000 | .10013+00 | -.32948-01 | .20692+00 | .46977+00 | .44251+00 | -.41086+00 | .47553+00 | .50402-02 | .71105+00 |
| 6 | .00000 | .44351-01 | -.38855-01 | -.67050-01 | -.35208+00 | .16819+00 | .79247-01 | .29241+00 | .11332+00 | .64716+00 |
| 5 | .00000 | .00000 | -.10851+00 | .30969+00 | -.52956+00 | .44251+00 | -.45994+00 | .11094+00 | -.93146-01 | -.26447+00 |
| 4 | .00000 | .00000 | -.27025+00 | .12994+00 | .97631-01 | -.14330+00 | .59026-01 | .12360+00 | .94356-01 | -.91586-01 |
| 3 | .00000 | .00000 | .00000 | .10656+00 | -.14101+00 | .19575+00 | -.60077+00 | -.20797+00 | .39540+00 | -.24194-01 |
| 2 | .00000 | .00000 | .00000 | .00000 | .00000 | .65888-01 | -.33646+00 | .37323+00 | -.31991+00 | -.96762-01 |
| 1 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .13809+00 | .12188-01 | .22712-01 |

TIME = .500

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | -.14665+00 | .76623-01 | .57466-01 | | | | | | | |
| 19 | .22010+00 | .45365+00 | -.18531-01 | .14804+00 | -.64725-01 | | | | | |
| 18 | .25303-01 | -.50987-01 | .33949+00 | .62640-01 | -.32621+00 | -.56675+00 | -.68808+00 | | | |
| 17 | -.25588+00 | .97774-01 | -.28685+00 | .66973-01 | .33182-01 | -.12703+00 | -.21735+00 | .13189+00 | | |
| 16 | -.73860-01 | .52773+00 | .34637+00 | .35800-01 | -.46297+00 | -.33595+00 | -.47757+00 | .94250-03 | | |
| 15 | -.20871-01 | -.13558+00 | -.20296+00 | -.36463+00 | -.33688+00 | -.21210+00 | .96297-01 | -.87906+00 | -.23532+00 | |
| 14 | .28504+00 | -.10828-01 | -.91566-01 | .30620+00 | .13981+00 | -.15921+00 | -.42483+00 | -.18248+00 | -.43814+00 | |
| 13 | -.10720+01 | .81641-01 | -.55776+00 | -.13130+00 | -.13876+00 | .25812+00 | .69934+00 | -.46603+00 | .46791+00 | -.17209-01 |
| 12 | .52781+00 | .31203+00 | .21651+00 | .90128+00 | .56413+00 | .43147+00 | .44931+00 | -.51597+00 | -.11527+00 | -.20991+00 |
| 11 | -.77771+00 | .11436+00 | -.37984+00 | .10026+00 | -.52112+00 | -.34775+00 | -.86871-01 | -.48355-01 | .47406 00 | -.68646+00 |
| 10 | .15966+00 | .72191+00 | .54103+00 | .91763+00 | .57636-01 | -.25105+00 | -.26398+00 | -.27182+00 | .55759 02 | -.39303+00 |
| 9 | -.10353+01 | .56028-01 | -.56612+00 | .46442+00 | -.53445+00 | .24725+00 | .16859+00 | .58490-03 | -.24079+00 | -.33011+00 |
| 8 | .72615-01 | .80345+00 | .33483+00 | .86025+00 | -.32791+00 | .23134+00 | -.59076+00 | -.32738+00 | -.10322+00 | -.92474-01 |
| 7 | -.42602+00 | .57464+00 | .33894-01 | .23789+00 | -.42312+00 | -.75833-01 | -.65987-01 | .17199-01 | -.60073-01 | |
| 6 | .35040+00 | .21993+00 | -.89151-01 | .31880+00 | .23699+00 | -.25569+00 | -.69782+00 | -.32686+00 | -.31689+00 | |
| 5 | .42013+00 | .11515+00 | .24164+00 | .78495-01 | .13497+00 | -.12700+00 | .34685+00 | .83359-02 | | |
| 4 | .29933+00 | -.55455-01 | .29933+00 | -.37524+00 | -.22116+00 | -.39539+00 | -.34335+00 | -.45678+00 | | |
| 3 | .48352+00 | .13547+00 | .26311+00 | -.14689+00 | .45719+00 | -.73453-01 | .20100+00 | | | |
| 2 | .51736-01 | .28639+00 | .21429+00 | -.21804+00 | -.87190-02 | | | | | |
| 1 | .21687+00 | .32400+00 | .23045+00 | | | | | | | |

RELATIVE DENSITY (LBM/FT$^3$)

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .50865-02 | .49819-02 | .56062-02 |
| 19 | .00000 | .00000 | .00000 | .00000 | .00000 | .55742-02 | .56426-02 | .55991-02 | .54828-02 | .62999-02 |
| 18 | .00000 | .00000 | .00000 | .58573-02 | .52348-02 | .57285-02 | .60648-02 | .57641-02 | .57206-02 | .61086-02 |
| 17 | .00000 | .00000 | .54399-02 | .59545-02 | .52910-02 | .58633-02 | .56476-02 | .56642-02 | .56625-02 | .62088-02 |
| 16 | .00000 | .00000 | .58334-02 | .59805-02 | .53606-02 | .57757-02 | .64751-02 | .61302-02 | .64315-02 | .67875-02 |
| 15 | .00000 | .57972-02 | .52678-02 | .41623-02 | .57346-02 | .58726-02 | .56916-02 | .60903-02 | .59129-02 | .63354-02 |
| 14 | .00000 | .61541-02 | .62372-02 | .61776-02 | .61999-02 | .56436-02 | .62360-02 | .65612-02 | .58925-02 | .69176-02 |
| 13 | .57830-02 | .60832-02 | .56379-02 | .65631-02 | .58596-02 | .53969-02 | .56269-02 | .65194-02 | .51023-02 | .61255-02 |
| 12 | .54819-02 | .56331-02 | .58606-02 | .59818-02 | .62869-02 | .41814-02 | .52157-02 | .60252-02 | .59159-02 | .66204-02 |
| 11 | .58963-02 | .55469-02 | .53472-02 | .60265-02 | .64022-02 | .48510-02 | .53758-02 | .59131-02 | .40289-02 | .57128-02 |
| 10 | .60611-02 | .60201-02 | .58751-02 | .61589-02 | .60534-02 | .41642-02 | .60182-02 | .59494-02 | .63810-02 | .70929-02 |
| 9 | .58134-02 | .58210-02 | .58128-02 | .62369-02 | .56799-02 | .57123-02 | .50968-02 | .59036-02 | .46883-02 | .67300-02 |
| 8 | .54399-02 | .52416-02 | .57275-02 | .57882-02 | .59101-02 | .42863-02 | .51248-02 | .68651-02 | .64460-02 | .73015-02 |
| 7 | .00000 | .60432-02 | .58499-02 | .61987-02 | .65786-02 | .45395-02 | .53053-02 | .65860-02 | .59047-02 | .69264-02 |
| 6 | .00000 | .59610-02 | .58420-02 | .57733-02 | .53879-02 | .41417-02 | .60121-02 | .63215-02 | .60628-02 | .68336-02 |
| 5 | .00000 | .00000 | .57414-02 | .63459-02 | .51334-02 | .45385-02 | .52316-02 | .60593-02 | .57641-02 | .65160-02 |
| 4 | .00000 | .00000 | .62883-02 | .60870-02 | .60390-02 | .56913-02 | .59830-02 | .60773-02 | .60343-02 | .67679-02 |
| 3 | .00000 | .00000 | .00000 | .60528-02 | .56955-02 | .41816-02 | .50289-02 | .55990-02 | .64712-02 | .68634-02 |
| 2 | .00000 | .00000 | .00000 | .00000 | .00000 | .59930-02 | .54110-02 | .64385-02 | .54357-02 | .58314-02 |
| 1 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .60975-02 | .59160-02 | .59316-02 |

TIME = .500

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | .56851-02 | .60074-02 | .59794-02 | | | | | | | |
| 19 | .62158-02 | .65532-02 | .58705-02 | .61101-02 | .58040-02 | | | | | |
| 18 | .59336-02 | .58228-02 | .63896-02 | .59873-02 | .54251-02 | .50762-02 | .49023-02 | | | |
| 17 | .62665-02 | .60380-02 | .54828-02 | .59929-02 | .59437-02 | .57138-02 | .55834-02 | .60887-02 | | |
| 16 | .57900-02 | .66607-02 | .64002-02 | .59476-02 | .52282-02 | .54116-02 | .52065-02 | .58970-02 | | |
| 15 | .58663-02 | .57012-02 | .56041-02 | .53704-02 | .54092-02 | .55905-02 | .59633-02 | .52045-02 | .55572-02 | |
| 14 | .63101-02 | .58820-02 | .57664-02 | .63408-02 | .60990-02 | .56666-02 | .52842-02 | .56338-02 | .52637-02 | |
| 13 | .43476-02 | .60170-02 | .50900-02 | .57079-02 | .56973-02 | .42702-02 | .69082-02 | .52238-02 | .65748-02 | .58716-02 |
| 12 | .66614-02 | .71266-02 | .62132-02 | .72009-02 | .67113-02 | .45228-02 | .65490-02 | .51518-02 | .57310-02 | .55946-02 |
| 11 | .47604-02 | -.14979-02 | .53333-02 | .60438-02 | .51432-02 | .53947-02 | .58697-02 | .58276-02 | .65832-02 | .49043-02 |
| 10 | -.10437-02 | -.18295+01 | -.14244-02 | .80925-02 | .59829-02 | .55344-02 | .55150-02 | .55031-02 | .59059-02 | .53289-02 |
| 9 | .43884-02 | -.15437-02 | .50654-02 | .65706-02 | .51243-02 | .42551-02 | .61414-02 | .58976-02 | .55498-02 | .54214-02 |
| 8 | .60034-02 | .78304-02 | .63884-02 | .71422-02 | .54240-02 | .42331-02 | .50429-02 | .54250-02 | .57490-02 | .57658-02 |
| 7 | .52818-02 | .67298-02 | .59470-02 | .62436-02 | .52866-02 | .47897-02 | .58031-02 | .59232-02 | .58114-02 | |
| 6 | .44036-02 | .62171-02 | .67693-02 | .63595-02 | .62412-02 | .55273-02 | .43898-02 | .54255-02 | .54401-02 | |
| 5 | .65062-02 | .60652-02 | .62481-02 | .60113-02 | .60939-02 | .57148-02 | .64006-02 | .59108-02 | | |
| 4 | .63321-02 | .58181-02 | .63315-02 | .53562-02 | .55785-02 | .53270-02 | .54021-02 | .52380-02 | | |
| 3 | .68861-02 | .60942-02 | .62788-02 | .56866-02 | .65605-02 | .57926-02 | .61883-02 | | | |
| 2 | .59727-02 | .63122-02 | .62092-02 | .55836-02 | .58859-02 | | | | | |
| 1 | .62126-02 | .63671-02 | .62330-02 | | | | | | | |

RELATIVE TEMPERATURE (R)

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .12016-03 | .10872-03 | .16594-03 |
| 19 | .00000 | .00000 | .00000 | .00000 | .00000 | .16403-03 | .16975-03 | .16594-03 | .15450-03 | .22888-03 |
| 18 | .00000 | .00000 | .00000 | .18883-03 | .13351-03 | .17548-03 | .20599-03 | .17738-03 | .17548-03 | .21172-03 |
| 17 | .00000 | .00000 | .15068-03 | .19836-03 | .13733-03 | .18883-03 | .16785-03 | .16975-03 | .16975-03 | .22125-03 |
| 16 | .00000 | .00000 | .18692-03 | .19836-03 | .14305-03 | .18120-03 | .24223-03 | .21172-03 | .24033-03 | .27084-03 |
| 15 | .00000 | .18120-03 | .13351-03 | .21362-03 | .17548-03 | .18883-03 | .17166-03 | .20599-03 | .19264-03 | .23079-03 |
| 14 | .00000 | .21172-03 | .22125-03 | .21362-03 | .21744-03 | .16594-03 | .22125-03 | .24986-03 | .18883-03 | .28419-03 |
| 13 | .17738-03 | .20599-03 | .16594-03 | .24796-03 | .18692-03 | .14305-03 | .16594-03 | .24605-03 | .11635-03 | .20981-03 |
| 12 | .15068-03 | .16403-03 | .18692-03 | .19646-03 | .22316-03 | .21362-03 | .12779-03 | .20027-03 | .18883-03 | .25558-03 |
| 11 | .18883-03 | .15450-03 | .13924-03 | .19836-03 | .23270-03 | .27466-03 | .14114-03 | .18883-03 | .19073-04 | .16594-03 |
| 10 | .20218-03 | .19836-03 | .18692-03 | .21172-03 | .20218-03 | .21172-03 | .19836-03 | .19455-03 | .22128-03 | -.36488-02 |
| 9 | .17929-03 | .17929-03 | .18120-03 | .21744-03 | .16975-03 | .17166-03 | .11444-03 | .18692-03 | .76294-04 | .25749-03 |
| 8 | .14687-03 | .12779-03 | .16975-03 | .17738-03 | .18883-03 | .22316-03 | .11635-03 | .27466-03 | .23460-03 | .31471-03 |
| 7 | .00000 | .19836-03 | .18120-03 | .21172-03 | .24605-03 | .24223-03 | .13161-03 | .24796-03 | .18692-03 | .27847-03 |
| 6 | .00000 | .19264-03 | .18120-03 | .17357-03 | .14114-03 | .20599-03 | .19646-03 | .22316-03 | .20027-03 | .27084-03 |
| 5 | .00000 | .00000 | .17166-03 | .22697-03 | .11444-03 | .24223-03 | .12589-03 | .19836-03 | .17166-03 | .14877-03 |
| 4 | .00000 | .00000 | .22125-03 | .20027-03 | .19836-03 | .16594-03 | .19264-03 | .20027-03 | .19646-03 | .17166-03 |
| 3 | .00000 | .00000 | .00000 | .19836-03 | .16403-03 | .20981-03 | .10490-03 | .15450-03 | .23460-03 | .18120-03 |
| 2 | .00000 | .00000 | .00000 | .00000 | .00000 | .19264-03 | .14114-03 | .23270-03 | .14305-03 | .17738-03 |
| 1 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .20218-03 | .18311-03 | .18692-03 |

TIME = .500

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | .17357-03 | .20218-03 | .20027-03 | | | | | | | |
| 19 | .22125-03 | .25368-03 | .18883-03 | .21172-03 | .18311-03 | | | | | |
| 18 | .19455-03 | .18692-03 | .23460-03 | .20027-03 | .14877-03 | .11826-03 | .10109-03 | | | |
| 17 | .22507-03 | .20409-03 | .15259-03 | .20027-03 | .19646-03 | .17548-03 | .16212-03 | .20790-03 | | |
| 16 | .18120-03 | .25940-03 | .23460-03 | .19455-03 | .13161-03 | .14682-03 | .12970-03 | .19264-03 | | |
| 15 | .18692-03 | .17166-03 | .16403-03 | .14305-03 | .14687-03 | .16403-03 | .19646-03 | .12779-03 | .15831-03 | |
| 14 | .22697-03 | .18692-03 | .17738-03 | .22888-03 | .20981-03 | .16975-03 | .13351-03 | .16594-03 | .13351-03 | |
| 13 | .47684-04 | .18883-03 | .11635-03 | .17166-03 | .16975-03 | .22316-03 | .28038-03 | .12779-03 | .24796-03 | .18692-03 |
| 12 | .25368-03 | .38872-02 | .20981-03 | .30708-03 | .26512-03 | .24605-03 | .24605-03 | .12016-03 | .17357-03 | .16212-03 |
| 11 | .15068-03 | .40277-01 | .21172-03 | .19455-03 | .12016-03 | .14305-03 | .18692-03 | .18311-03 | .24986-03 | .99182-04 |
| 10 | .38225-01 | .99832-01 | .43213-01 | -.42953-02 | .17929-03 | .15450-03 | .15259-03 | .15259-03 | .18692-03 | .14305-03 |
| 9 | .11635-03 | .40064-01 | .18311-03 | .24033-03 | .11826-03 | .22125-03 | .20981-03 | .18883-03 | .15450-03 | .14305-03 |
| 8 | .18883-03 | -.37975-02 | .22316-03 | .29945-03 | .14305-03 | .21744-03 | .10872-03 | .14305-03 | .17357-03 | .17357-03 |
| 7 | .12970-03 | .24986-03 | .18883-03 | .21553-03 | .13161-03 | .17548-03 | .17738-03 | .18883-03 | .17738-03 | |
| 6 | .23270-03 | .21362-03 | .17548-03 | .22697-03 | .21744-03 | .15259-03 | .91553-04 | .14305-03 | .14496-03 | |
| 5 | .24033-03 | .19836-03 | .21744-03 | .19646-03 | .20218-03 | .16975-03 | .23079-03 | .18692-03 | | |
| 4 | .22316-03 | .17738-03 | .22316-03 | .13542-03 | .15450-03 | .13351-03 | .13924-03 | .12398-03 | | |
| 3 | .27466-03 | .20218-03 | .21744-03 | .16403-03 | .24223-03 | .17357-03 | .21172-03 | | | |
| 2 | .18883-03 | .22125-03 | .21172-03 | .15450-03 | .18120-03 | | | | | |
| 1 | .21172-03 | .22507-03 | .21172-03 | | | | | | | |

VELOCITY U (FT/SEC)

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .12140-01 | -.44521-02 | .67307-02 |
| 19 | .00000 | .00000 | .00000 | .00000 | .00000 | .10373-01 | .12598-01 | .13673-01 | .32422-03 | .91088-02 |
| 18 | .00000 | .00000 | .00000 | .10834-01 | -.62345-02 | -.83485-03 | -.56524-02 | -.69215-04 | -.78909-03 | .34625-02 |
| 17 | .00000 | .00000 | -.13644-02 | .10319-01 | -.33589-02 | .65705-03 | .73943-02 | .35997-02 | .52658-02 | .85693-02 |
| 16 | .00000 | .00000 | -.17226-01 | -.10688-02 | -.47648-02 | .33310-02 | -.79392-02 | .10740-02 | -.52214-02 | .65648-05 |
| 15 | .00000 | -.11557-01 | .33239-03 | .83107-02 | -.36630-02 | .16477-01 | .13995-02 | .38593-02 | .51936-02 | -.35795-02 |
| 14 | .00000 | -.27466-02 | -.13812-01 | .64269-02 | -.11873-01 | -.98543-02 | -.12724-01 | -.12248-01 | -.44248-02 | .78119-02 |
| 13 | -.12174-02 | .23293-02 | -.70905-02 | .69049-02 | -.46604-02 | .13023-01 | .23597-02 | -.34699-02 | -.61187-03 | -.13694-02 |
| 12 | -.10275-01 | .46796-02 | -.21978-01 | .23350-04 | -.18437-01 | -.18892-01 | -.20945-01 | -.10495-01 | -.12630-01 | .50162-02 |
| 11 | -.76220-02 | .55110-02 | .34505-02 | .68497-02 | .45188-02 | .10909-01 | -.17375-01 | -.53152-02 | -.13714-01 | .11134-01 |
| 10 | -.26425-02 | .10310-02 | -.28601-01 | -.33429-03 | -.22444-01 | -.17683-01 | -.21975-01 | -.73144-02 | -.52641-01 | -.92617-02 |
| 9 | -.98995-02 | .10607-01 | -.16977-02 | -.16781-02 | -.11495-02 | .02304-02 | -.14685-01 | .44280-03 | -.12576-02 | .28056-02 |
| 8 | -.27576-02 | .13309-02 | -.17884-01 | -.64099-03 | -.23147-01 | -.73646-02 | -.11232-01 | -.38335-02 | -.18732-01 | -.72649-02 |
| 7 | .00000 | .47305-02 | .38662-02 | .10498-01 | -.31857-02 | .79129-02 | -.12989-01 | .67350-02 | .26632-03 | -.27046-02 |
| 6 | .00000 | .10122-01 | -.14870-01 | -.43196-02 | -.10763-01 | -.36107-02 | -.12306-01 | -.66892-02 | -.10787-01 | .56870-02 |
| 5 | .00000 | .00000 | .46979-02 | -.32801-02 | -.52601-02 | .13682-01 | -.46197-02 | .10573-01 | -.51991-02 | .77017-02 |
| 4 | .00000 | .00000 | -.13762-01 | -.74106-02 | -.15284-01 | .35611-03 | -.41223-02 | .43751-02 | -.10778-01 | .81632-02 |
| 3 | .00000 | .00000 | .00000 | -.61227-02 | -.49538-02 | -.41670-03 | -.54231-02 | .16840-01 | .15348-03 | -.44781-02 |
| 2 | .00000 | .00000 | .00000 | .00000 | .00000 | .05328-02 | .49369-02 | .10888-01 | -.44847-02 | .40542-02 |
| 1 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .15298-01 | -.66307-02 | -.13345-02 |
| TIME = | .500 | | | | | | | | | |
| 20 | .93905-02 | .11032-02 | .17804-01 | | | | | | | |
| 19 | .33170-02 | -.14348-02 | .47907-02 | -.76474-03 | .92313-02 | | | | | |
| 18 | .10057-01 | .11967-01 | .16616-01 | -.65232-04 | .56152-02 | .29399-02 | .96136-02 | | | |
| 17 | -.58224-02 | -.13165-02 | .51931-02 | .35033-02 | .12995-01 | .15576-02 | .67021-02 | .15994-02 | | |
| 16 | .10223-01 | .10461-01 | .10527-01 | -.96773-03 | .70227-02 | .44175-02 | .21454-01 | .98425-02 | | |
| 15 | -.97260-02 | .67896-02 | -.35521-02 | -.42354-02 | .15625-01 | .82619-03 | .12549-01 | -.12411-02 | .65301-02 | |
| 14 | -.12606-01 | .72636-02 | .20794-01 | .13623-01 | .21535-01 | .64480-02 | .31735-01 | .10135-01 | .18326-01 | |
| 13 | -.10531-01 | .68516-02 | .73711-02 | .40432-02 | .17313-01 | -.23481-02 | .11587-01 | .50661-02 | .15954-01 | -.98207-03 |
| 12 | -.39263-01 | .15281-02 | .48300-01 | .23473-01 | .41498-01 | .16281-01 | .34653-01 | .13416-01 | .34649-01 | .60402-02 |
| 11 | -.86599-02 | -.13077-02 | .13056-01 | .38271-02 | .29028-01 | .24225-02 | .24474-01 | .10733-01 | .21237-02 | -.23597-01 |
| 10 | -.11660+00 | .19529-01 | .13099+00 | .70971-02 | .68482-01 | .15859-01 | .61042-01 | .46713-01 | .61246-01 | .41385-01 |
| 9 | -.14500-01 | .74698-02 | .28791-01 | .68531-02 | .13029-01 | -.83797-02 | .20783-01 | .44174-02 | .98178-02 | .42473-02 |
| 8 | -.39637-01 | .60636-02 | .36193-01 | .16377-01 | .52993-01 | .56354-02 | .43005-01 | .24417-01 | .23519-01 | .16627-01 |
| 7 | -.21396-03 | -.21591-02 | .72550-02 | -.28039-02 | .15427-01 | .57557-02 | .11760-01 | .18552-02 | .10139-01 | |
| 6 | -.15600-03 | .16337-02 | .19199-01 | .19350-01 | .26294-01 | .80801-03 | .31094-01 | .16888-01 | .89037-02 | |
| 5 | -.50783-03 | -.70317-02 | .13889-01 | .68070-02 | .19307-01 | -.35925-02 | -.47079-03 | -.10470-01 | | |
| 4 | .99762-02 | .15484-02 | .15728-01 | .52898-03 | .18144-01 | .38587-02 | .60435-02 | .21454-02 | | |
| 3 | .60573-02 | .12252-01 | .11320-01 | .29513-02 | .12711-01 | -.27385-02 | .26119-02 | | | |
| 2 | .71613-02 | .85743-02 | .91706-02 | -.24291-02 | .16898-01 | | | | | |
| 1 | .71779-02 | .63188-02 | .24053-01 | | | | | | | |

## VELOCITY V (FT/SEC)

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | -.89937-02 | -.97350-02 | -.19374-01 |
| 19 | .00000 | .00000 | .00000 | .00000 | .00000 | .84248-02 | -.59099-02 | .17854-01 | .56183-02 | .13706-01 |
| 18 | .00000 | .00000 | .00000 | -.11703-01 | -.22060-01 | -.42615-02 | -.13949-01 | .62753-03 | -.40884-02 | -.42708-02 |
| 17 | .00000 | .00000 | .10708-01 | .76950-02 | .52954-02 | .59972-02 | .25903-02 | .82873-02 | .13751-02 | .12706-01 |
| 16 | .00000 | .00000 | .37724-02 | -.29758-02 | .55229-02 | -.26113-02 | -.10301-01 | .34755-02 | -.10568-01 | .36711-02 |
| 15 | .00000 | .10183-01 | -.80494-03 | .29518-02 | -.83[illegible]2-02 | .10056-01 | .47238-02 | .14843-01 | .17912-01 | .14034-0[illegible] |
| 14 | .00000 | -.43628-02 | -.13063-01 | .29481-02 | -.1[illegible]7-01 | .40163-02 | -.82038-02 | .31962-02 | -.87726-03 | .92495-02 |
| 13 | .40342-02 | -.28001-02 | -.14623-01 | .50455-02 | -.82717-02 | .11612-01 | .64208-03 | .19852-01 | -.13577-02 | .28062-01 |
| 12 | .88931-02 | .11827-01 | .51778-02 | .12883-02 | .52382-02 | -.78386-02 | .73593-02 | .12035-01 | .92042-02 | .25545-01 |
| 11 | -.32501-02 | -.69725-02 | .50845-03 | -.33270-03 | .83123-03 | .36894-02 | -.47173-03 | .47758-02 | -.39924-02 | .46064-01 |
| 10 | -.34761-02 | -.22559-02 | -.84356-02 | .29063-02 | .93669-04 | .85748-02 | .17709-02 | .58838-02 | -.39862-02 | -.65756-02 |
| 9 | .66738-02 | .65445-02 | .60518-02 | -.42073-02 | .63939-02 | -.35226-02 | -.38247-02 | -.14323-01 | -.69628-02 | -.40510-01 |
| 8 | -.39746-04 | -.27765-02 | .99892-02 | -.85004-02 | -.21872-02 | -.45240-02 | -.86971-03 | -.83669-02 | -.71587-02 | -.10301-01 |
| 7 | .00000 | .37587-02 | .15090-02 | .49306-03 | .52347-02 | -.11940-01 | .16029-02 | -.10886-01 | .67049-02 | -.10831-01 |
| 6 | .00000 | .63468-02 | .38248-02 | .24738-02 | .17351-01 | .44672-02 | .11583-01 | -.40398-02 | .77490-02 | .11750-02 |
| 5 | .00000 | .00000 | -.43025-02 | -.17539-01 | -.13682-02 | -.13018-01 | -.52372-02 | -.21213-01 | -.18168-01 | -.21201-01 |
| 4 | .00000 | .00000 | -.15192-01 | .29809-02 | .47782-03 | .28879-02 | .14871-01 | .36140-02 | .86107-02 | -.10627-02 |
| 3 | .00000 | .00000 | .00000 | .28105-02 | .80163-02 | -.72807-02 | .59193-02 | -.15940-01 | -.31497-03 | -.20181-01 |
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| TIME = .500 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | -.14230-01 | -.69774-02 | -.97164-02 | | | | | | | |
| 19 | .90563-02 | .13236-01 | -.20279-02 | .94254-02 | .43300-02 | | | | | |
| 18 | -.35395-02 | .49851-02 | -.36762-02 | .44822-02 | -.84300-02 | -.16848-01 | -.17792-01 | | | |
| 17 | .47731-02 | .12537-01 | .62739-02 | .18628-01 | .67279-02 | .16823-01 | .52933-02 | .20310-01 | | |
| 16 | .15783-02 | .76616-02 | -.65346-02 | .16307-01 | .12039-02 | .13530-01 | .19441-02 | .79915-02 | | |
| 15 | .99705-02 | .36813-01 | .13172-01 | .26618-01 | -.74867-03 | .12144-01 | -.25954-02 | .25763-02 | -.14133-02 | |
| 14 | -.31607-02 | .10393-01 | -.31735-02 | -.98231-03 | -.11476-01 | -.28871-02 | -.83564-02 | -.21117-02 | -.13729-01 | |
| 13 | .10391-02 | .54444-01 | .47773-02 | .27238-01 | -.46219-02 | .73180-02 | -.14122-01 | .45086-02 | -.17409-01 | -.12203-01 |
| 12 | -.33059-02 | .25314-01 | .48446-02 | .17955-01 | .50253-02 | .57788-02 | .15974-03 | -.74066-02 | -.57889-02 | .53664-02 |
| 11 | .86755-02 | .12240+00 | -.68888-02 | .39691-01 | .11218-01 | .12430-01 | .12091-01 | -.13987-01 | -.20727-01 | -.36244-01 |
| 10 | .43581-02 | -.14967-03 | -.44250-02 | -.16477-01 | -.74649-02 | -.47951-03 | .33374-02 | .32152-02 | .96784-02 | -.40953-02 |
| 9 | -.73430-02 | -.12545+00 | .56873-02 | -.30646-01 | -.53165-02 | -.14873-01 | .44596-02 | .32037-02 | .26240-01 | .35507-01 |
| 8 | -.16471-02 | -.26230-01 | .79871-02 | -.30294-02 | .17671-01 | -.49666-02 | .36047-02 | .43241-02 | .55086-02 | -.17358-01 |
| 7 | -.58473-02 | -.58036-01 | -.14140-02 | -.41338-01 | -.48355-02 | -.14668-01 | -.32749-03 | -.28766-02 | .58355-02 | |
| 6 | -.26508-02 | -.11292-02 | .22302-02 | -.51370-02 | -.73575-02 | -.87308-02 | .20404-02 | .34855-02 | -.42963-02 | |
| 5 | -.20506-01 | -.31283-01 | -.20418-01 | -.27882-01 | -.17594-02 | -.19762-01 | -.50117-02 | .50423-02 | | |
| 4 | .20792-01 | -.85164-02 | .15147-02 | -.58485-02 | .53852-02 | .91862-03 | .48086-02 | -.15536-02 | | |
| 3 | .38373-02 | -.17383-01 | -.31462-02 | -.10360-01 | -.65181-04 | -.89583-02 | -.31980-02 | | | |
| 2 | .75682-03 | -.63833-02 | .74970-02 | -.69482-03 | .15431-01 | | | | | |
| 1 | .46688-02 | -.57520-02 | .99286-02 | | | | | | | |

## 6.0 REFERENCES


1. "Apollo Cryogenic Storage System Analysis Task Plan," R. K. M. Seto, TRW Project Technical Report 17618-H014-R0-00, September, 1970.

2. "A Numerical Solution for the Prediction of Pressure Collapse in Supercritical Oxygen," P. J. Heinmiller, TRW Project Technical Report 17618-H080-R0-00, December 1970.

3. "Programmer's Guide for the GNAT Computer Program," P. J. Heinmiller, TRW Project Technical Report 17618-H106-R0-00, February, 1971.